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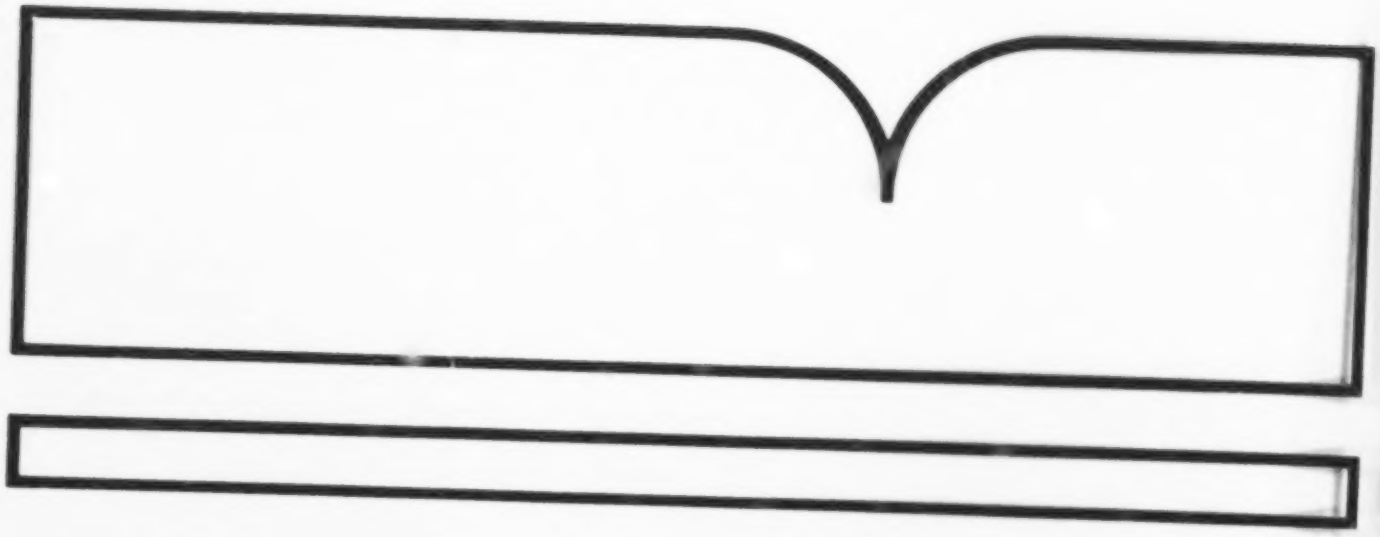

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Effects of Ground ULV Applications of Fenthion on Estuarine Biota V. Responses of Field and Laboratory Estuarine Benthic Communities[1]

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ABSTRACT

The effects of fenthion on macrobenthic animals that colonized sand-filled boxes at two salt marsh sites were determined after two field sprayings within 5 days and in the laboratory after intermittent exposures that simulated field conditions. ULV ground applications for adult mosquito control resulted in water concentrations ≤ 0.68 µg fenthion/l at one site and ≤ 0.38 µg/l at the other site. There were no statistically significant differences ($\alpha = 0.05$) in average numbers of benthic individuals and species (primarily annelids and arthropods) that colonized control communities and those exposed to these concentrations.

The average numbers of individuals and species of animals that colonized sand-filled boxes in the laboratory (during 9 wk by planktonic larvae from continuously supplied unfiltered seawater) were not significantly affected by two treatments at 1.1 µg fenthion/l or by four treatments at 1.3 µg/l. However, the average number of species in communities exposed to two treatments at 11.8 µg/l was significantly less than that in control communities and those exposed to lower concentrations. Mean abundances of mollusks, arthropods, and chordates were substantially (19 or more percent), but not statistically significantly, lower in this concentration than in the control.

INTRODUCTION

Toxicity tests were conducted on benthic communities as part of the field research program, detailed elsewhere in this issue, to assess applicability of laboratory test data to field results. This paper describes effects of fenthion (Baytex) on macrobenthic animals that colonized sand-filled boxes in two estuarine lagoons after spraying to control adult mosquitoes and in the laboratory after simulated field exposure. Test design was similar to that used in earlier toxicity studies on field- and laboratory-developed estuarine benthic communities (Tagatz and Deans, 1983; Tagatz et al., 1982, 1983).

Benthic animals are desirable test organisms since many are sedentary and, therefore, particularly susceptible to toxicant exposure. In addition, benthic communities serve as a critically important link to higher trophic levels. Food sources of fishes, such as hake, flounders, catfish, croaker, and red drum, are dominated by epibenthic crustaceans and infaunal organisms, especially polychaetes (Vittor, 1979). Therefore, benthic communities are an important component in comprehensive ecological studies.

METHODS AND MATERIALS

Field-Colonized Communities

Fenthion applied as a ground ULV aerosol (equivalent to 0.01 lb per acre, 11 g per ha) was evaluated against benthic communities during Sprays 1 and 2 at Sites 1 and 2. Detailed site description, pesticide application methods, spray conditions, and efficacy of treatment for Sprays 1 and 2 are given by Clark et al. in this issue.

Eighteen sand-filled boxes (32 × 32 × 6 cm deep, constructed of acrylic plastic) were placed in each of the lagoons at Sites 1 and 2 for colonization by benthic animals. Clean sand (82% of the particles were from 0.35 to 0.5 mm) dredged a few months previously from Santa Rosa Sound filled the boxes. Particle sizes of the natural sediment in each lagoon differed with location and ranged from silt to coarse sand. Boxes at Site 1 were grouped near the middle of the lagoon, about 37 m (120 ft) from the nearest point of fenthion discharge. Those at Site 2 were near the lagoon inlet, about 137 m (450 ft) from pesticide discharge. They were positioned so that their surfaces were level with the sur-

[1]Contribution No. 523e Environmental Research Laboratory, Gulf Breeze, FL.

rounding sand at 0.3 m (1 ft) depth at low tide or 0.6 m (2 ft) depth at high tide.

Benthic animals were allowed to colonize the sand in the boxes for 8 wk prior to application of fenthion. One-half of the boxes at each site served as a control and were harvested on 3 May, 2 days before the first fenthion spray; the remaining boxes were harvested on 12 May, 2 days after the second spray. The control boxes were placed in the field 1 week earlier than those exposed to fenthion so that colonization time would be similar. Although periods of colonization in control boxes and in boxes exposed to fenthion were somewhat different, we believed that communities thus formed at one site would be more alike than communities simultaneously formed at two sites, a spray site and a distant control site that would not be contaminated by fenthion.

Fifteen min to 24 hr after each spray, water samples were collected near the experimental communities and analyzed for fenthion. Detailed results of these analyses are found in Moore et al. (this issue).

Weekly maximum and minimum water temperatures and a weekly salinity were measured near the experimental communities to document environmental conditions during the study. Recorded temperatures at Site 1 average 17°C (8 to 26°C) and those at Site 2, 20°C (4 to 33°C). Average salinity recorded at Site 1 was 8 $^{0}/_{00}$ (2 to 14 $^{0}/_{00}$); at Site 2, 5 $^{0}/_{00}$ (1 to 10 $^{0}/_{00}$) over 9 wk period.

Communities were harvested by emptying the contents of each box into a pail with a nitex-screen bottom (1-mm mesh), agitating the screen in the lagoon water, and removing the screen with retained material from the bottom of the pail. The screen was formed into a bag to hold the retained material for processing through an animal relaxer (propylene phenoxetol in water) and for fixing in formalin that contained rose bengal stain. Preserved animals were counted and identified in the laboratory.

Laboratory-Colonized Communities

We also determined the effects of fenthion on benthic animals that colonized similar sand-filled boxes in the laboratory for comparison of results with those obtained in the field. Groups of four boxes were placed in each of eight box frames that, when filled, contained a 3-cm layer of water over the sand (Fig. 1). The boxes were colonized for 9 wk (28 February to 2 May 1983) by settling planktonic larvae entrained in continuously supplied unfiltered seawater from Santa Rosa Sound. Water from the Sound flowed to a splitter box from which eight adjacent glass tubes supplied water at 1.5 l/min to the center of each frame. Water flowed from the frame through notched openings on all sides. Salinity and temperature of seawater entering the laboratory (recorded as daily minimum and maximum) averaged 18.5 $^{0}/_{00}$ (7.0 to 31.5 $^{0}/_{00}$) and 16.0°C (11.5 to 21.0°C) during colonization. Photoperiod was 12L:12D; light was supplied by four 1.2-m fluorescent lamps (34 watt).

Fenthion (97% pure), dissolved in triethylene glycol, was metered by syringe pump through flexible polyethylene tubing and injected through a side opening in the glass tubing that carried seawater to each treated frame. An equal amount of carrier solvent (14 µl/l) was metered into the water that entered the control frames. Communities were exposed intermittently during colonization because repeated applications at varying intervals characterize fenthion exposure-patterns in the field. Each exposure was for 8 hr, which simulated the maximum retention of fenthion that would be expected to occur in tidal-marsh waters between tidal races prior to low and high water. Eight boxes (two frames) served as a control, eight received nominal concentration of 1.4 µg fenthion/l and eight received 14.0 µg/l at 4 and 8 wk, and eight were exposed to 1.4 µg/l at 2, 4, 6, and 8 wk. Fourteen µg/l simulated 80% field-spray fallout in an acre-ft (0.4 ha/0.3m) of water from an application of 0.05 lb/acre (56 g/ha, usual rate for various application methods), and 1.4 µg/l simulated 8% fallout, a more realistic environmental concentration. Water samples for analyses for fenthion were taken from each frame during the mid-point of each 8-hr exposure.

After 9 wk of colonization, the communities were harvested. Animals retained by a 1-mm mesh sieve were relaxed (menthol and magnesium sulphate in

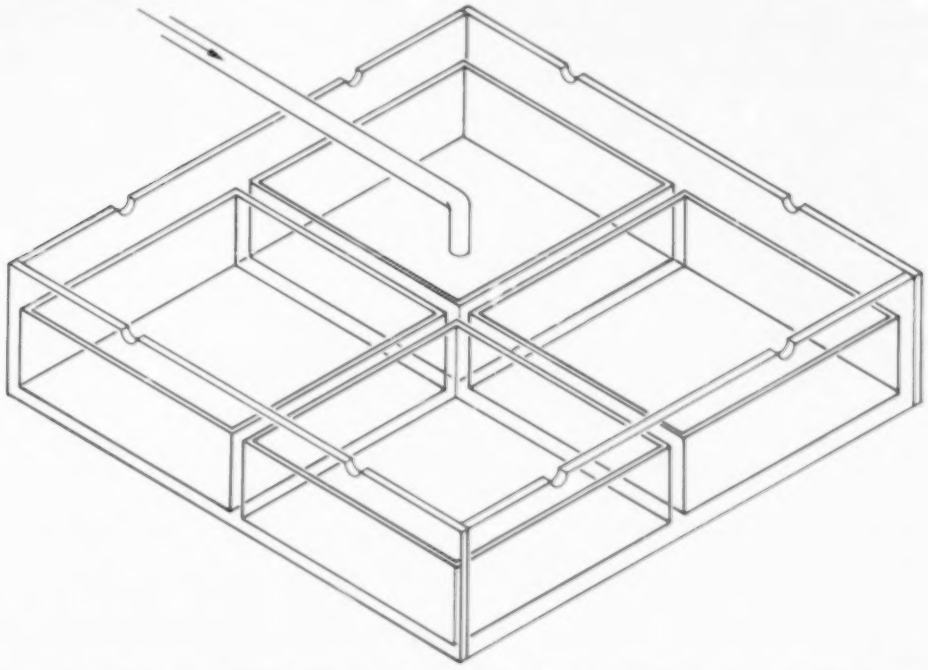

Fig. 1 Arrangement of laboratory boxes, four per frame, to test the effects of fenthion on macrobenthic communities. Seawater was continously supplied at 1.5 l/min to the center.

water), preserved in formalin or alcohol, counted and identified.

Statistical Analysis

The numbers of individuals and species collected from control boxes were compared statistically (Winer, 1971) with those in boxes exposed to fenthion (α = 0.05). Two-sample t-tests were used for field data to compare the mean number of animals in the exposed group with the mean number in the control group by phylum and by selected species. An analysis of variance was used for laboratory data to compare the mean number of animals in the control group and the three treatment groups by phylum and by selected species. For any significant treatment effect, Duncan's multiple comparison procedure was used to determine which treatments differed from one another.

RESULTS

Field-Colonized Communities

The highest fenthion concentrations measured in surface water adjacent to the benthic communities at Site 1 after the first spray were 0.064 µg/l after 15 min and 0.059 µg/l after 2 hr; 0.014 µg/l persisted at 12 hr. After the second spray, highest concentrations of fenthion were 0.68 µg/l after 15 min and 0.48 µg/l after 1 hr; 0.012 µg/l persisted at 12 hr. No fenthion was detected 18 and 24 hr after either spray. Fenthion also occurred at the bottom of the water column, as indicated by surface and bottom water samples taken after the second application at 2 hr (surface 0.28 µg/l; bottom, 0.17 µg/l), 4 hr (0.071 and 0.11 µg/l), 6 hr (0.12 and 0.053 µg/l), and 12 hr (0.012 and 0.047 µg/l).

After the first spray, highest fenthion concentrations measured in surface waters adjacent to the benthic communities at Site 2 were 0.032 µg/l after 4 hr and 0.023 µg/l after 6 hr; 0.011 µg/l persisted at 12 hr. No fenthion was detected at 18 and 24 hr. After the second spray, highest concentrations of fenthion were 0.38 µg/l after 30 min and 0.28 µg/l after 1 hr; 0.036 µg/l persisted at 24 hr. Water samples were collected only at the surface at Site 2.

During colonization at Site 1, scouring action of waves and currents removed

Table 1. Animals in field-colonized benthic communities collected from control boxes and from boxes exposed to two fenthion applications ≤0.68 µg/l at Site 1 and ≤0.38 µg/l at Site 2. Replicates were pooled.

Taxon	Site 1		Site 2	
	Control	Treated	Control	Treated
ANNELIDA				
Haploscoloplos sp.	35	34	51	16
Laeonereis culveri	17	52	1	15
Amphicteis gunneri floridus	26	7	22	15
Heteromastus filiformis	10	2	9	8
Eteone hepteropoda	5	6	0	1
Arenicola cristata	2	0	—	—
Loandalia fauvelli	2	0	0	4
Capitella capitata	1	0	—	—
Melinna maculata	—	—	1	0
Streblospio benedicti	—	—	1	0
Unident. Oligochaeta	3	3	5	0
Total annelids	101	104	90	59
ARTHROPODA				
Lipidactylus dytiscus	53	43	1	0
Leptochelia rapax	3	6	1	0
Taphromysis bowmani	4	1	—	—
Grandidierella bonnieroides	1	2	1	0
Edotea montosa	2	0	—	—
Unident. amphipod	—	—	1	0
Unident. Chironomidae larva	0	2	52	93
Total arthropods	63	54	56	93
MOLLUSCA				
Anomalocardia auberiana	1	1	1	1
Brachidontes exustus	1	0	1	0
Hydrobia sp.	0	1	—	—
Neritina reclivata	0	1	—	—
Odostomia sp.	0	1	—	—
Tellina sp.	0	1	—	—
Total moilusks	2	5	2	1
RHYNCHOCOELA				
Unident. nemertean	1	1	7	3
Total All Phyla:				
Individuals	167	164	155	156
Species	17	17	15	9

sand from 3 control boxes and from 3 boxes to be exposed to fenthion. These were not used in the analysis of data. All 18 boxes at Site 2 retained their sand.

A total of 331 animals representing 22 species of 4 phyla was collected at Site 1, and 311 animals of 17 species and 4 phyla were collected at Site 2 (Table 1). At both sites, there were no significant differences in the mean numbers of individuals and species between the controls and the communities exposed to fenthion (Table 2). In addition, the abundance of the dominant phyla, annelids (primarily polychaete worms) and arthropods (primarily amphipods at Site 1 and midge larvae at Site 2) did not differ significantly between control and treated communities. The number of the polychaete, *Haploscoloplos* sp. (Orbiniidae), was much lower in treated boxes than in control boxes at Site 2, but not at Site 1. However, abundance of *Laeonereis culveri* (Nereidae) at both sites was greater in treated communities than in control communities.

Laboratory-Colonized Communities

Averages and ranges of fenthion concentrations (µg/l) measured in water from communities treated twice (1.4 or 14.0 nominal) were 1.1 (0.90 to 1.3) for the low concentration and 11.8 (11.0 to 12.0) for the high concentration. Fenthion in water from communities treated four times at the low concentration averaged 1.3 (1.1 to 1.5).

Table 2. Average no. of animals and average no. of species (standard error of mean) per box collected from field-colonized boxes.

Taxon	Site 1		Site 2	
	Control	Treated*	Control	Treated*
Annelida	16.8 (4.0)	17.3 (3.5)	10.0 (2.1)	6.6 (1.7)
Arthropoda	10.5 (9.7)	9.0 (2.8)	6.2 (1.2)	10.3 (2.2)
Mollusca	0.2 (0.2)	0.2 (0.2)	0.2 (0.2)	0.1 (0.1)
Rhynchocoela	0.3 (0.2)	0.8 (0.4)	0.8 (0.3)	0.3 (0.2)
All Phyla:				
Individuals	27.8 (13.3)	27.3 (5.3)	17.2 (2.7)	17.4 (3.6)
Species	7.2 (1.2)	7.0 (1.1)	4.8 (0.6)	4.4 (0.6)

*None significantly different from control ($\alpha = 0.05$), using two-sample t-test.

Table 3. Animals in laboratory-colonized benthic communities collected from control boxes and from boxes exposed to two or four eight-hr treatments of fenthion. Replicates were pooled.

Taxon	No. of treatments and conc.			
	Control	Two 1.1 µg/l	Four 1.3 µg/l	Two 11.8 µg/l
MOLLUSCA				
Ensis minor	387	368	377	352
Mulinia lateralis	215	201	168	137
Lyonsia hyalina floridana	3	1	1	0
Brachidontes exustus	1	1	0	0
Polinices duplicatus	0	0	1	1
Doridella obscura	0	0	0	1
Total mollusks	606	571	547	491
CHORDATA				
Molgula manhattensis	175	171	162	127
ANNELIDA				
Neanthes succinea	13	14	20	26
Polydora sp.	17	9	11	12
Unident. Sabellidae	6	4	1	3
Armandia agilis	1	2	7	3
Cistenides gouldii	3	4	3	0
Capitella capitata	0	3	0	0
Capitellides jonesi	1	0	0	1
Haploscoloplos sp.	0	1	1	0
Sabella micropthalma	0	0	1	0
Streblospio benedicti	1	0	0	0
Total annelids	42	37	44	45
ARTHROPODA				
Balanus amphitrite niveus	35	28	16	14
Oxyurostylis smithi	1	3	3	0
Corophium acherusicum	0	2	0	0
Acanthohaustorius sp.	1	0	0	0
Calinectes similis	0	0	1	0
Total arthropods	37	33	20	14
CNIDARIA				
Unident. anemone	1	1	2	2
RHYNCHOCOELA				
Cerebratulus lacteus	0	1	0	0
Total All Phyla:				
Individuals	861	814	775	679
Species	16	17	16	12

A total of 3,129 animals representing 24 species of 6 phyla was collected (Table 3). Although not statistically significant, the mean abundances of mollusks, arthropods (primarily *Balanus amphitrite*), chordates (*Molgula manhattensis*), and of all

Table 4. Average no. of animals and average no. of species (standard error of mean) per box collected from laboratory-colonized boxes.

Taxon	Control	No. of treatments and conc. Two 1.1 µg/l	Four 1.3 µg/l	Two 11.8 µg/l
Mollusca	75.8 (6.1)	71.4 (6.4)	68.3 (5.4)	61.4 (4.6)
Chordata	21.9 (2.0)	21.4 (1.2)	20.3 (1.9)	15.9 (1.6)
Annelida	5.3 (0.5)	4.6 (0.5)	5.5 (1.1)	5.6 (1.5)
Arthropoda	4.6 (1.0)	4.1 (1.4)	2.5 (0.3)	1.8 (0.5)
Chidaria	0.1 (0.1)	0.1 (0.1)	0.3 (0.2)	0.3 (0.2)
Rhynchocoela	0.0	0.1 (0.1)	0.0	0.0
All Phyla:				
Individuals	107.6 (6.4)	101.8 (7.6)	96.9 (7.6)	84.9 (5.0)
Species	8.0 (0.5)	8.1 (0.4)	7.9 (0.5)	6.1 (0.4)*

*Significantly different from control and other treatments ($\alpha = 0.05$), using analysis of variance.

phyla collectively were substantially lower (19 or more percent) in 11.8 µg fenthion/l than in the control (Table 4). The number of annelids was about the same as that in the control. The average number of species in communities exposed to 11.8 µg/l was significantly less than that in communities exposed to lower concentrations or in the control. There were no significant differences in the average numbers of individuals and species between the control communities and those exposed to lower concentrations of fenthion.

DISCUSSION

Results of our laboratory studies suggest that significant mortality would not occur among macrobenthic communities exposed in the field to multiple treatments ≤1.3 µg fenthion/l. Therefore, it was not surprising that no significant impact occurred in the field after two exposures at ≤0.68 µg/l. Comparisons between laboratory and field effects are limited since laboratory communities were dominated by mollusks and the chordate, *Molgula manhattensis*, and to a lesser degree by annelids and arthropods, the dominant phyla in field communities. Animal communities in 10 four-inch (10-cm) field cores collected at each site on 23 April 1983 also were dominated by polychaete worms and the same types of arthropods found in our field boxes. As in the field boxes, few mollusks and no chordates occurred in the cores. Our laboratory studies indicate that concentrations of fenthion in water ≥11.8 µg/l could have a significant impact on the composition of macrobenthic communities exposed in the field. However, the field study showed that these concentrations did not occur in typical ULV ground sprays of fenthion for control of adult salt marsh mosquitoes.

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REFERENCES CITED

Clark, J. R., D. P. Middaugh, M. J. Hemmer, B. W. Clements, Jr., j. C. Dukes, and C. B. Rathburn, Jr. Effects of ground ULV applications of fenthion on estuarine biota. I. Study design and implementation. This issue.

Moore, J. C., E. M. Lores, J. R. Clark, P. Moody, J. Knight and J. Forester. Effects of ground ULV applications of fenthion on estuarine biota. II. Analytical methods and results. This issue.

Tagatz, M. E., N. R. Gregory and G. R. Plaia. 1982. Effects of chlorpyrifos on field- and laboratory-developed estuarine benthic communities. J. Toxicol. Environ. Health 10:411-421.

Tagatz, M. E. and C. H. Deans. 1983. Comparison of field- and laboratory-developed estuarine benthic communities for toxicant-exposure studies. Water Air Soil Pollut. 20:199-209.

Tagatz, M. E., C. H. Deans, J. C. Moore and G. R. Plaia. 1983. Alterations in composition of field- and laboratory-developed estuarine benthic communities exposed to di-n-butyl phthalate. Aquatic Toxicol. 3:239-248.

Vittor, B. A. 1979. Benthos of the Mobile Bay Estuary. In: Symposium on the Natural Resources of the Mobile Estuary, Alabama, May, 1979. H. A. Layaco and J. P. Smith (eds.). U.S. Army Corps of Engineers, Mobile District. pp. 143-149.

Winer, B. J. 1971. Statistical principles in experimental design, 2nd ed. McGraw-Hill, New York. 907 pp.

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